

330

STX

B685

No. 1310 COP 2



BEBR

FACULTY WORKING
PAPER NO. 1310

Intraday Return and Volatility Patterns in the
Stock Market: Futures versus Spot

Joseph E. Finnerty
Hun Y. Park

THE LIBRARY OF THE

FEB 11 1987

UNIV. OF ILLINOIS

College of Commerce and Business Administration
Bureau of Economic and Business Research
University of Illinois, Urbana-Champaign

BEBR

FACULTY WORKING PAPER NO. 1310

College of Commerce and Business Administration

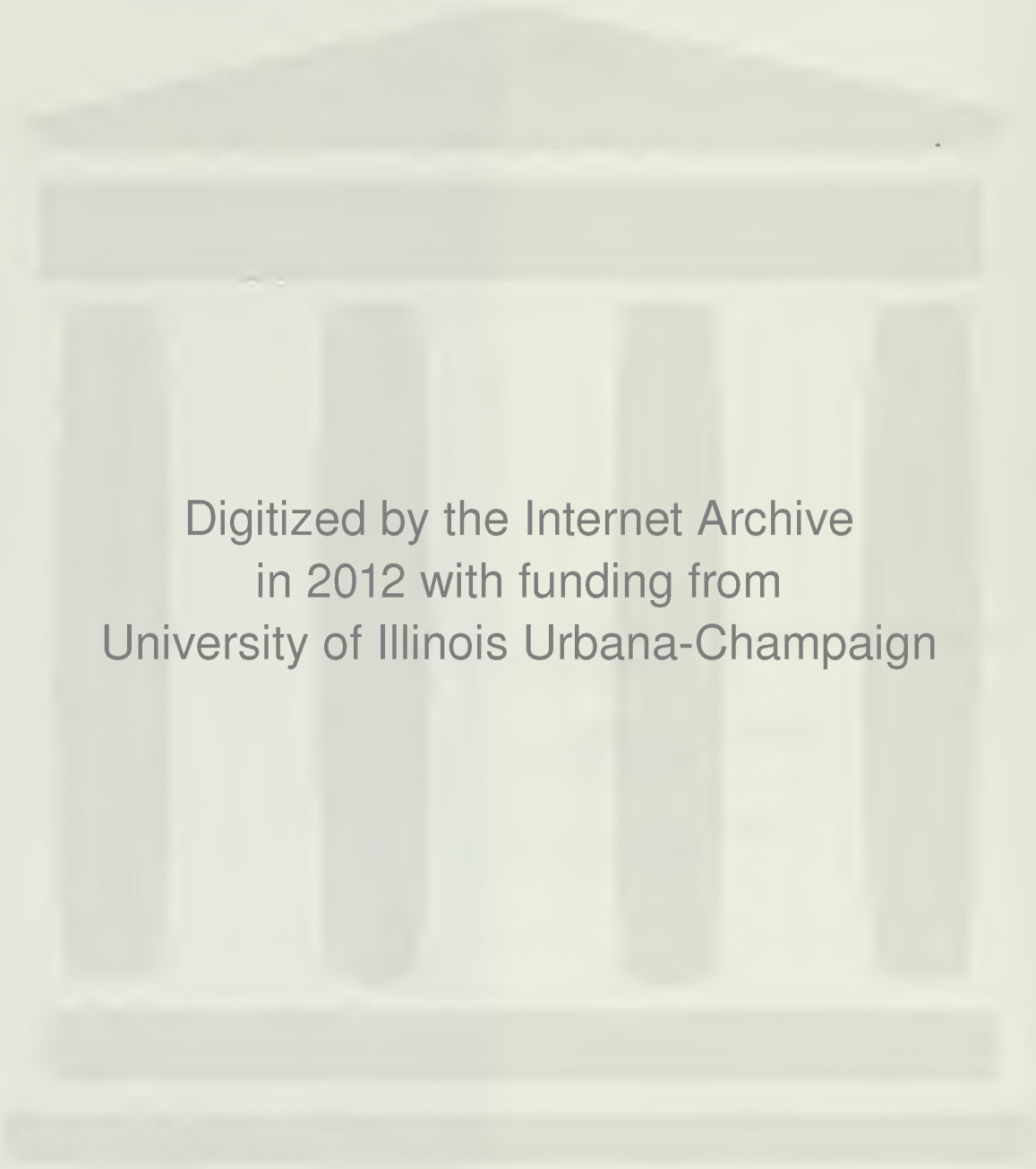
University of Illinois at Urbana-Champaign

November 1986

Intraday Return and Volatility Patterns in the Stock Market:
Futures versus Spot

Joseph E. Finnerty, Associate Professor
Department of Finance

Hun Y. Park, Assistant Professor
Department of Finance



Digitized by the Internet Archive
in 2012 with funding from
University of Illinois Urbana-Champaign

Intraday Return and Volatility Patterns in the Stock Market: Futures versus Spot

Abstract

We investigate the existence of intraday return and volatility patterns in the spot as well as in the futures markets of common stocks. Confirming the results of previous studies on weekend effects (i.e., the significant negative Monday return in the spot market but not in the futures market), we also provide new findings. The negative weekend effect in the spot market is found to start from around 1:30 p.m. on Friday (not from closing) and end at around 9:00 a.m. on Monday, 30 minutes after trading is open. We find a systematic and significant intraday volatility behavior of prices in the spot market, but no such occurrences in the futures market. A lunch hour effect is detected, where price movements are minimal during the lunch period in both the spot and futures markets. An unexplained anomaly is the persistent negative trend in prices for both spot and futures on Wednesday.

Intraday Return and Volatility Patterns in the Stock Market: Futures versus Spot

I. Introduction

One of the mind-boggling issues in finance research recently is the systematic pattern of stock returns during the week, i.e., the weekend effect. A number of studies have examined the daily common stock returns (e.g., French (1980), Gibbons and Hess (1981), Lakonishok and Levi (1982), Rogalski (1984), and Keim and Stambaugh (1984)). The common conclusion in the previous studies is that Monday returns tend to be negative and less than those on the other weekdays, and that the differences between Monday returns and average weekday returns are statistically significant and pervasive across securities. A recent study (Lakonishok and Smidt (1986)) documented the negative Monday effect using the Dow Jones Industrial Average for 90 years. However, the causes for the weekend effects are not fully understood and remain puzzling, at least at the present time, although some studies have debated on whether the Monday negative returns might be due to a different institutional settlement procedure, transaction costs or measurement error.¹

A recent study, Cornell (1985), tested the weekend effects in the S&P 500 spot and futures markets utilizing opening and closing prices. He found that the Monday effect exists due to the peculiar behavior of cash prices during nontrading hours. The return from Friday's close to Monday's open was found significantly negative in the S&P 500 spot index for the period of May 3, 1982-July 24, 1984. However, he did not find a similar pattern for S&P 500 futures for the sample period. He also found notably that on an open-to-close basis, Monday average

returns were higher than any other day of the week, not only in the spot but in the futures index.

The purpose of this study is multifold. First, we further investigate the weekend effects in the spot as well as in the futures markets, using actually transacted closing and opening prices of the Major Market Index and its futures contracts. The MMI is a price-weighted index of 20 blue chips, 15 of which are included in the Dow Jones 30 Industrials; see Appendix for the companies included in the MMI. Second, we examine intraday returns for the spot and futures, in an attempt to examine exactly from what time on Friday to what time on Monday the weekend effect takes place, and to investigate whether there exists a systematic pattern of prices during the day. To the authors' best knowledge, there is only one study concerning intraday price patterns. Harris (1986) used intraday data to analyze returns on NYSE stocks for the 14 months between December 1981 and January 1983. The most notable finding was that the negative Monday returns accrued mostly in the first 45 minutes of trading, and on Tuesday through Friday, prices rose significantly in the first 45 minutes of trading. He also found that the very large positive returns accrued over the last 15 minutes of trading on all weekdays. This paper further investigates the intraday systematic return patterns in the spot stock market and compares them with those in the futures market. This test will be particularly interesting to traders who wish to time their trades, since the presence of a systematic intraday return pattern may lead to a profitable timing strategy. Third, we also examine the intraday volatility behavior of prices in both futures and spot markets to better understand the intraday return patterns, if any.

The next section describes the data and presents empirical results. Confirming the results of the previous studies on the weekend effect, we provide new findings. First, we find that the weekend effect takes place starting from around 1:30 p.m. on Friday until around 9:00 a.m. on Monday, 30 minutes after trading is open. Second, the volatility of spot prices for the first 30 minutes of trading is shown to be abnormally high compared to other trading hours during the day, and the volatility for the last 30 minutes of trading prior to the close of the market is relatively low. However, we could not find the intraday volatility pattern in the futures market as significant as that in the spot market. Third, we show a lunch hour effect, where price movements are minimal during the 12 to 1 hour in both the spot and futures markets. Fourth, more interestingly, a significantly negative trend in prices for both the spot and futures markets is detected on Wednesday, which we find puzzling. The last section contains a brief conclusion.

II. Data and Empirical Results

The data consists of all intraday spot and futures prices of the Major Market Index over the period July 23, 1984 to July 15, 1986. The initial data base included every transaction as reported for the futures contracts and the values of the spot index occurring one to four times every minute of the trading day, so that a percentage change was available for each minute of trading at minimum. For the weekly return pattern part of the study, the opening and closing prices for the MMI Index and the most actively traded MMI futures

contract were used. Following Cornell (1985), all holidays and the days following holidays are excluded from the sample so that all daily returns in this paper are one-day and weekend returns. For the sample period, there are sixteen holidays, five on Monday, two on Tuesday, three on Wednesday, three on Thursday, and four on Friday. For the intraday return portion of the study, prices were taken at 15 minute intervals starting from the opening and ending at the close. For the majority of the contracts this was 8:45 a.m. to 3:15 p.m., however, for the more recent contracts the opening had been moved to 8:15 a.m. The most actively traded futures contract in general was the nearby contract except for the delivery month when the next contract became the most actively traded.

The closing prices for the MMI Index are plotted in Figure 1 for the period July 1984 to July 1986. During this period the MMI stocks increased by over 60 percent, therefore on average we would expect to find positive daily returns.

The results for the day of the week effect portion of the study are reported in Table 1. For the Spot and Futures prices these returns are calculated; 1) close to close, 2) close to open, and 3) open to close. Their means and standard deviations, and two F-statistics for each day are reported. The first F-statistic is for the hypothesis that the means of the daily returns are equal during the week, and the second F-statistic is for the hypothesis that all of them are equal to zero.

For the spot index, the results confirm the findings of Cornell (1985), Rogalski (1984) and Gibbons and Hess (1981). The return from Friday's close to Monday's open is significantly negative indicating

the existence of a weekend effect. However, the negative return is offset by the high return when trading is occurring, so that the return from close to close is positive. All of the other daily average returns are not significantly different from zero, indicating that there is no day of the week effect except for Monday. The results for the futures shows no significant day of the week effects on any day, thereby providing support for the efficient market hypothesis with respect to futures trading.

It is interesting, however, to observe that only on Wednesday, the returns from open to close for both spot and futures markets are negative, which indicates the downward trend of prices during the day. This becomes clearer when we examine the intraday return patterns.

The intraday return patterns allow us to look at specific periods during the trading day when price changes are more likely to occur. If the readers have ever had the opportunity to visit an exchange and view the trading activity, there seems to be great importance associated with the opening and closing of the market. As the bell rings, the traders burst into a cacophony of sound and motion, likewise at the close, the trading reaches a feverish pitch, then at the bell, silence.

In order to assess any systematic trading patterns that may be present during various parts of the trading day, the spot and futures price data was analyzed over 15 minute intervals. An adjustment was made for the change in the opening of the MMI futures contract trading from 8:15 a.m. to 8:45 a.m. by treating those contracts that were opened at 8:15 a.m. as if they opened at 8:45 a.m. This adjustment

only affected the first 15 minute trading period for the futures contracts results. The opening price at 8:15 a.m. was used to calculate the interval return as:

$$\frac{F_{9:00 \text{ a.m.}} - F_{8:15}}{F_{8:15}} \times 100 = \% \text{ of return}$$

where $F_{8:15}$ is the opening price of the MMI contract. The earlier MMI futures and spot interval returns were calculated by

$$\frac{P_t - P_{\text{OPEN}}}{P_{\text{OPEN}}} \times 100 = \% \text{ return}$$

where P_t is the price at 15 minute intervals during the day and P_{open} is the opening price on the respective market.

These cumulative 15 minute interval returns are presented in Table 2 for the MMI futures contracts and in Table 3 for the spot MMI index.

The results from Table 2 are plotted in Figure 2 to make the comparison between days easier. The symbols are: M = Monday, T = Tuesday, W = Wednesday, H = Thursday, F = Friday. In comparing the various days of MMI futures contracts, Wednesday stands out as a day where on average prices trend continually lower. Monday, Tuesday and Thursday trend upward, while Friday with the most volatility winds up with little change. The MMI futures contract on average opens down on Monday for the first half hour and then trends upward for the remainder of the day. All of the other days on average have a positive return for the first 15 minutes of trading. Interestingly, there does appear

to be a lunch hour effect from noon to 1 p.m. where price changes tend to diminish except Monday and Wednesday.

From these results, while there appears to be differences between the mean returns during a given day, the differences may not be economically significant if you have to pay commissions. However, if you wish to incorporate these results in the timing of your purchase and sales of futures contracts, you may be better off buying near the close on Wednesday afternoon and selling near the close on Thursday.

In Figure 3, the cumulative intraday returns are plotted for the spot MMI. The weekend effect of negative returns on Mondays open is easily seen. Again of interest is the continual downward trend of prices on Wednesday. The lunch hour effect seems to be little longer in the spot market lasting from noon to 1:30 p.m. where prices seem to decline. At the close prices are up on average for all days but Friday. On Friday prices begin trending downward at 1:30 p.m. and continue their downward trend till the close. Judging from Figure 3, the negative weekend effect in the spot market appears to start from around 1:30 p.m., not from the close on Friday, and end at around 9:00 a.m. on Monday. The return from 1:30 p.m. on Friday to 9:00 a.m. on Monday is calculated to be $-.1479\%$ (with the standard deviation $.0686$) which is much lower than the return from close to open on Monday in Table 1.

In an attempt to better understand the intraday return pattern and the day of the week effect, we examined the intraday volatility behavior in each day of the week. Figures 4 and 5 present the volatility of futures prices and spot prices, respectively, from the opening time to

9:00 a.m. and for every 30 minutes thereafter. Since the index and its futures prices were reported at least once every minute in some cases three or four times per minute, we had enough observations to calculate the volatility (the standard deviation) of prices. The number of observations for each calculation of the average standard deviation ranges from 82 to 102. Figure 5 presents a dramatic volatility behavior of spot prices. However, in Figure 4, it does not appear that such a significant pattern of the volatility exists in the futures market even though the volatility tends to decline around the closing time.

The volatility of spot prices is very high around the opening time (i.e., from opening to 9:00 a.m.) and in general declines until noon and goes up after the lunch hour.³ It is also noticeable that the volatility drops significantly prior to the close in each day. The Tables 4 and 5 present the average intraday volatility of prices and its t-statistic, and F-statistic in each day during the week for the futures and spot markets, respectively. The F-statistic is for the hypothesis that the average volatilities in all the segmented trading hours during the day are equal. All of the F-statistics in Tables 4 and 5 are significant at the one percent level which implies that there exists a systematic volatility pattern in the futures and spot market. Note, however, that the F-statistics in the spot market are much higher than those in the futures market, which is attributable to the high volatility of prices around the opening time in the spot market.

The high volatility of spot prices around the opening time may not be surprising since the information created in nontrading hours are

likely to affect stock prices when the market is open. French and Roll (1985), using returns from closing to closing prices of common stocks listed in the New York and American Stock Exchanges, compared the return variance during trading hours with that during nontrading hours and found that the former is much higher than the latter. They suggested three hypotheses for the observed volatility pattern: 1) more public information arrival during trading hours, 2) private information only affecting prices through the trading of informed investors particularly when the market is open, and 3) the trading noise such as investors overreaction to each other's trades which might increase the volatility of prices when the market is open. Our results are consistent with the second and third hypotheses. If investors expect the higher volatility after the market is open, the price may decline for a short period of time so that we may observe negative returns from closing to opening prices. Note, however, that the volatility of spot prices around the opening time remains the same across all days during the week. If the volatility is proportional to the number of nontrading hours, then Monday's volatility is presumably at least three times as other days. The same level of the volatility around the opening time across all days and the negative return from closing to opening prices only on Monday still leave the Monday effect puzzling. Nevertheless, the absence of the existence of the significant volatility pattern in the futures market suggests that the well documented day of the week effect may be attributable to some institutional factors that are present only in the spot market.⁴

III. Conclusions

The day of the week results reported here confirm the findings of other studies, there is a weekend effect which on average depresses prices on Monday for the stocks of the MMI index. No such day of the week effect is present in MMI futures contracts.

However, using the intraday data, we provide new findings in this paper. First, the negative weekend effect in the spot market is found to take place starting from around 1:30 p.m. on Friday (i.e., not from closing) until around 9:00 a.m. on Monday, 30 minutes after trading is open. Second, the volatility of spot prices from the opening time to 9:00 a.m. is found to be abnormally high compared to other trading hours. However, we could not find the similar intraday volatility pattern in the futures market. The absence of such volatility pattern in the futures market, and the similar level of the volatility in the spot market around the opening time across all days leave the negative Monday effect still puzzling, but at least the results suggest that the day of the week effect in the spot market may be attributable to some institutional factors unique to the spot market. Third, there appears to be a lunch hour effect, where price movements are minimal during the 12 to 1 hour in both the futures and spot market. Most puzzling of all was the negative trend in prices for both the spot and futures markets on Wednesday. Further work needs in order to explain this mid week occurrence.

Footnotes

¹For example, Lakonishok and Levi (1982) argue that Friday trades carry slightly different settlement procedures, requiring five business days plus an additional day for check clearance. Due to the placement of Friday in the week, two additional weekend days are required before payment can be cleared. Thus, the normal settlement process initiated on Friday increased from eight to 10 days. Dyl and Martin (1985) tested this hypothesis. Noting that the settlement period was only four days prior to 1968, they calculated daily returns prior to and after this period and found that the Monday effect was not affected from one sample to another, rejecting Lakonishok and Levi hypothesis. Lakonishok and Levi (1985) argued in turn that four day settlement was not honored in practice prior to 1968 and they diluted their hypothesis, suggesting that settlement procedures could explain only a portion of negative returns on Monday.

²For the futures, the return from 1:30 p.m. on Friday to 9:00 a.m. on Monday is $-.1089\%$ (with the standard deviation $.6186$), which is also much lower than the close-to-open return on Monday in Table 1, although it is not still statistically significant.

³It is likely that all of the stocks in the MMI index do not begin to be traded simultaneously. If some of the stocks were not traded for a short period of time after the market is open, the volatility of the index would be lower than the case where all of the stocks are traded at the same time. Thus the volatility of the index reported in this paper would be a conservative measure and the comparison of the volatilities between the spot and futures markets is intact since the spot price volatility is much higher than the futures price volatility.

⁴We also examined the intraday trading volume of futures to see whether the intraday return and volatility patterns are related to the trading activities during the day. In general, trading is most active on Tuesday, followed by Wednesday, Monday, Thursday, and Friday. Regardless of the day, the trading volume increases significantly in an hour after the market is open until around 11:00 a.m. and becomes less active for about two hours thereafter. It regains activity from 1:00 p.m. until the market is closed. However, the intraday return patterns of futures do not appear to be influenced by the trading activity during the day. The trading volume for the spot MMI is not available since it is not an actually traded portfolio. However, if the intraday trading volumes of the stocks in the MMI were available, it may confirm similar findings in the spot market.

References

- Cornell, B., "The Weekly Pattern in Stock Returns: Cash versus Futures: A Note." Journal of Finance 40 (June 1985), p. 583-588.
- Dyl, E. A. and S. A. Martin, Jr., "Weekend Effects on Stock Return: A Comment." Journal of Finance 40 (March 1985), p. 347-350.
- French, K. R., "Stock Returns and Weekend Effect." Journal of Financial Economics 8, 1980, p. 55-69.
- _____ and R. Roll, "Stock Return Variances: The Arrival of Information and The Reaction of Traders," 1985, working paper, University of Chicago.
- Gibbons, M. R. and P. Hess, "Day of the Week Effects and Asset Returns," Journal of Business 54, 1981, p. 579-596.
- Harris, L., "How to Profit from Intradaily Stock Returns," Journal of Portfolio Management (Winter), 1986, p. 61-64.
- Keim, D. and R. Stambaugh, "A Further Investigation of the Weekend Effect in Stock Returns," Journal of Finance 39, 1984, p. 819-835.
- Lakonishok, J. and M. Levi, "Weekend Effects on Stock Returns: A Note," Journal of Finance 37, 1982, p. 883-889.
- _____, "Weekend Effects on Stock Returns: A Reply," Journal of Finance 40, 1985, p. 351-352.
- Rogalski, R. J., "New Findings Regarding Day of the Week Returns over Trading and Nontrading Periods," unpublished working paper, Dartmouth College, 1984.

Table 1

Day of the Week Returns for MMI Spot and Futures (%)
(July 23, 1984 to July 15, 1986)

	Monday	Tuesday	Wednesday	Thursday	Friday	F-statistic
Observations	94	96	97	96	96	
MMI Spot Close to Close						
Mean	-.005	.154	-.036	.208	.136	.863
Std. Dev.	.788	.840	.874	.862	.887	1.209
MMI Spot Close to Open						
Mean	-.121*	.006	.006	.004	.077	2.323*
Std. Dev.	.061	.043	.033	.045	.051	2.428*
MMI Spot Open to Close						
Mean	.116	.148	-.043	.203	.059	.830
Std. Dev.	.781	.829	.870	.847	.977	1.323
MMI Futures Close to Close						
Mean	.141	.169	-.047	.215	.017	1.630
Std. Dev.	.745	.871	.910	.866	.858	1.779
MMI Futures Close to Open						
Mean	.027	.104	.028	.026	.016	1.505
Std. Dev.	.329	.232	.259	.260	.334	1.754
MMI Futures Open to Close						
Mean	.114	.066	-.076	.189	.001	1.458
Std. Dev.	.692	.883	.869	.843	.866	1.628

*Significant at the 5 percent level.

^aThe first F-statistic is for the hypothesis that all the coefficients are equal in the regression $R_t = b_1 D_1 + b_2 D_2 + b_3 D_3 + b_4 D_4 + b_5 D_5 + \epsilon_t$, where R_t is the return on the spot or futures and D_1 through D_5 represent day-of-the-week dummies. The second F-statistic is for the hypothesis that all the coefficients in the regression are equal to zero.

Table 2

Cumulative 15 Minute Intraday Percentage Return - MMI Futures

	Monday	Tuesday	Wednesday	Thursday	Friday
OPEN - 9:00 a.m.	-.018	.020	.008	.009	.018
9:00- 9:15	-.017	-.005	-.002	.039	.049
9:15- 9:30	-.014	.038	.002	.017	.059
9:30- 9:45	.012	.029	-.0003	.031	.032
9:45-10:00	-.0001	-.002	-.034	.037	.054
10:00-10:15	.004	-.014	-.064	.059	.052
10:15-10:30	-.0003	-.008	-.023	.037	.023
10:30-10:45	.006	.013	-.040	.064	.045
10:45-11:00	.007	.040	-.027	.068	.077
11:00-11:15	.017	.037	-.002	.071	.058
11:15-11:30	.057	.049	-.032	.088	.077
11:30-11:45	.035	.041	-.022	.128	.080
11:45-12:00	.083	.036	-.035	.115	.089
12:00-12:15	.071	.064	-.069	.115	* .129
12:15-12:30	.051	.061	* -.043	.115	.128
12:30-12:45	.052	* .065	-.042	* .142	.063
12:45- 1:00	.051	.003	-.048	.139	.057
1:00- 1:15	.067	.024	-.050	.102	.029
1:15- 1:30	.056	.046	-.077	.135	.069
1:30- 1:45	.034	.048	-.059	.170	.080
1:45- 2:00	.080	.063	-.108	.149	.034
2:00- 2:15	.088	.050	-.143	.152	.056
2:15- 2:30	.113	.070	-.114	.108	-.002
2:30- 2:45	.124	.073	-.102	.137	-.026
2:45- 3:00	.135	.082	-.111	.174	-.033
3:00- CLOSE	.127	.094	-.100	.174	.005

*Changes are not significantly different from zero at the 10 per-
cent level of significance.

Table 3

Cumulative 15 Minute Intraday Percentage Returns - MMI Spot

	Monday	Tuesday	Wednesday	Thursday	Friday
OPEN - 9:00 a.m.	-.015	-.011	.026	.005	.0003
9:00- 9:15	-.055	.045	.027	.032	.060
9:15- 9:30	-.046	.068	.028	.016	.11
9:30- 9:45	-.026	.050	.028	.011	.088
9:45-10:00	-.024	.056	.008	.032	.018
10:00-10:15	-.023	.050	-.014	.048	.082
10:15-10:30	-.021	.039	-.014	.049	.063
10:30-10:45	-.016	.057	-.006	.054	.087
10:45-11:00	-.021	.053	-.017	.056	.086
11:00-11:15	-.011	.076	-.005	.062	.084
11:15-11:30	-.001	.077	.008	.077	.090
11:30-11:45	.013	.083	.004	.094	.087
11:45-12:00	.025	.089	-.021	.115	.104
12:00-12:15	.028	* .100	-.022	* .131	.103
12:15-12:30	.028	* .099	* -.028	.127	.114
12:30-12:45	.027	.103	-.031	.127	* .113
12:45- 1:00	.007	.096	-.049	.129	.090
1:00- 1:15	.008	.074	-.026	.125	.089
1:15- 1:30	.007	.083	-.038	.131	.098
1:30- 1:45	-.007	.092	-.036	.141	.099
1:45- 2:00	.021	.110	-.052	.139	.070
2:00- 2:15	.040	.103	-.054	.161	.065
2:15- 2:30	.071	.146	-.070	.131	.045
2:30- 2:45	.064	.128	-.069	.117	.033
2:45- CLOSE	.096	.134	-.041	.167	.031

*Changes are not significantly different from zero at the 10 percent level of significance.

Table 4

Intraday Price Volatility (Futures)^a
(July 23, 1984 to July 15, 1986)

Time		Monday	Tuesday	Wednesday	Thursday	Friday
----- 9:00	$\bar{\sigma}$	.2045	.2017	.2178	.2061	.2317
(a.m.)	t-statistics	15.45	14.84	14.74	13.26	14.38
	observations	88	93	92	94	95
9:00- 9:30	$\bar{\sigma}$	.2332	.2250	.2258	.2308	.2448
	t-statistics	18.05	16.91	15.70	15.00	15.19
	observations	92	98	97	96	95
9:30-10:00	$\bar{\sigma}$	.1742	.1858	.1862	.1870	.2076
	t-statistics	13.34	13.67	12.61	12.15	12.88
	observations	90	94	92	96	95
10:00-10:30	$\bar{\sigma}$	.1721	.1912	.1720	.1703	.2007
	t-statistics	13.18	14.22	11.57	10.89	12.26
	observations	90	96	91	93	92
10:30-11:00	$\bar{\sigma}$	.1799	.2078	.1893	.1921	.1845
	t-statistics	13.15	14.96	12.74	12.02	11.33
	observations	82	90	91	89	93
11:00-11:30	$\bar{\sigma}$	.1757	.1882	.1940	.1755	.2053
	t-statistics	13.15	13.62	12.92	11.17	12.27
	observations	86	91	89	92	88
11:30-12:00	$\bar{\sigma}$	.1685	.1705	.1784	.1875	.1699
	t-statistics	12.39	12.54	11.94	11.93	10.27
	observations	83	94	90	92	90
12:00-12:30	$\bar{\sigma}$	.1654	.1748	.1913	.2113	.1880
(p.m.)	t-statistics	12.45	12.93	13.16	13.66	11.30
	observations	87	95	95	95	89
12:30- 1:00	$\bar{\sigma}$	.1878	.1983	.1994	.1949	.1763
	t-statistics	14.05	14.75	13.42	12.46	10.59
	observations	86	96	91	93	89
1:00- 1:30	$\bar{\sigma}$	.2033	.2263	.2335	.2097	.2540
	t-statistics	15.31	16.92	15.80	13.56	15.51
	observations	87	97	92	95	92
1:30- 2:00	$\bar{\sigma}$	.2325	.2473	.2614	.2304	.2469
	t-statistics	17.80	18.39	18.26	14.98	15.16
	observations	90	96	98	96	93
2:00- 2:30	$\bar{\sigma}$	.2672	.2853	.3021	.3266	.2934
	t-statistics	21.02	21.44	21.21	21.34	18.11
	observations	95	98	99	97	94
2.30- 3:00	$\bar{\sigma}$	.2702	.2697	.2954	.3281	.3126
	t-statistics	21.14	20.58	20.64	21.43	19.40
	observations	94	101	98	97	95
3:00--	$\bar{\sigma}$	.1320	.1476	.1492	.1603	.1747
	t-statistics	10.38	11.09	10.37	10.53	11.01
	observations	95	98	97	98	98
F-statistic ^b		9.72	8.39	9.95	11.35	7.60

^aAll of the statistics are significant at 1 percent level.

^bThe F-statistic is for the hypothesis that all the coefficients are equal in the regression $\sigma_t = \alpha_1 D_1 + \alpha_2 D_2 + \dots + \alpha_{14} D_{14} + e_t$, where σ_t

is the standard deviation of prices for the segmented time period t during the day and D_1 through D_{14} represent the segmented time dummies during the day.

Table 5

Intraday Price Volatility (Spot)^a
(July 23, 1984 to July 15, 1986)

Time		Monday	Tuesday	Wednesday	Thursday	Friday
----- 9:00	$\bar{\sigma}$	.4260	.3780	.3882	.4190	.4231
(a.m.)	t-statistics	19.64	14.19	13.86	16.62	16.82
	observations	40	39	39	40	41
9:00- 9:30	$\bar{\sigma}$	.2967	.2597	.2621	.2843	.2746
	t-statistics	21.40	15.30	14.91	17.83	17.79
	observations	98	102	99	100	97
9:30-10:00	$\bar{\sigma}$	.1700	.1686	.1717	.1856	.1791
	t-statistics	12.26	9.93	9.76	11.65	11.01
	observations	98	102	99	100	98
10:00-10:30	$\bar{\sigma}$	.1475	.1683	.1397	.1633	.1741
	t-statistics	10.64	9.91	7.95	10.25	10.70
	observations	98	102	99	100	98
10:30-11:00	$\bar{\sigma}$	.1448	.1582	.1614	.1661	.1561
	t-statistics	10.44	9.32	9.18	10.42	9.59
	observations	98	102	99	100	98
11:00-11:30	$\bar{\sigma}$	.1389	.1536	.1615	.1592	.1578
	t-statistics	10.02	9.05	9.19	9.98	9.70
	observations	98	102	99	100	98
11:30-12:00	$\bar{\sigma}$	.1293	.1594	.1529	.1364	.1335
	t-statistics	9.33	9.39	8.70	8.56	8.20
	observations	98	102	99	100	98
12:00-12:30	$\bar{\sigma}$	.1284	.1640	.1643	.1629	.1364
(p.m.)	t-statistics	9.26	9.66	9.35	10.22	8.38
	observations	98	102	99	100	98
12:30- 1:00	$\bar{\sigma}$	.1626	.1736	.1602	.1596	.1374
	t-statistics	11.73	10.23	9.113	10.01	8.44
	observations	98	102	99	100	98
1:00- 1:30	$\bar{\sigma}$	.1682	.1964	.1872	.1533	.1924
	t-statistics	12.14	11.57	10.65	9.62	11.76
	observations	98	102	99	100	97
1:30- 2:00	$\bar{\sigma}$	.1786	.2013	.2374	.2099	.2146
	t-statistics	12.89	11.86	13.51	13.17	13.12
	observations	98	102	99	100	97
2:00- 2:30	$\bar{\sigma}$	.2416	.2756	.2736	.2865	.2336
	t-statistics	17.43	16.23	15.56	17.92	14.29
	observations	98	102	99	100	97
2.30- 3:00	$\bar{\sigma}$	.2353	.2786	.2952	.3033	.2672
	t-statistics	16.97	16.41	16.79	19.03	16.34
	observations	98	102	99	100	97
3:00--	$\bar{\sigma}$	.0835	.0709	.0834	.0937	.1365
	t-statistics	5.87	4.10	4.70	5.82	8.22
	observations	93	98	97	98	94
F-statistic ^b		25.52	14.19	14.75	20.89	15.20

^aAll of the statistics are significant at 1 percent level.

^bThe F-statistic is for the hypothesis that all the coefficients are equal in the regression $\sigma_t = \alpha_1 D_1 + \alpha_2 D_2 + \dots \alpha_{14} D_{14} + e_t$, where σ_t

is the standard deviation of prices for the segmented time period t during the day and D_1 through D_{14} represent the segmented time dummies during the day.

Figure 1

Trend of Spot Closing Price
(July 23, 1984 - July 15, 1986)

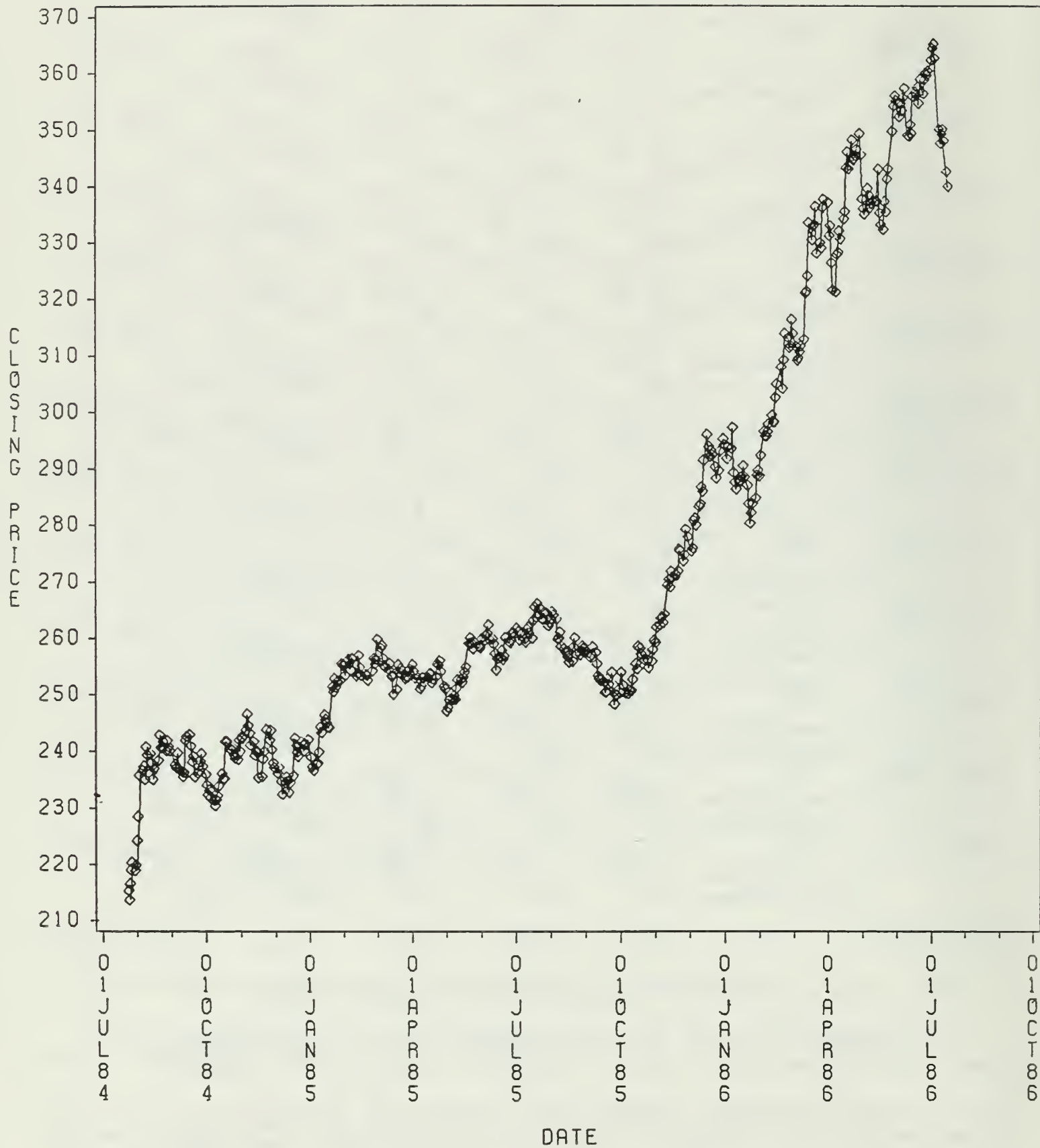


Figure 2

Cumulated 15-Minute Intraday Returns (Futures)

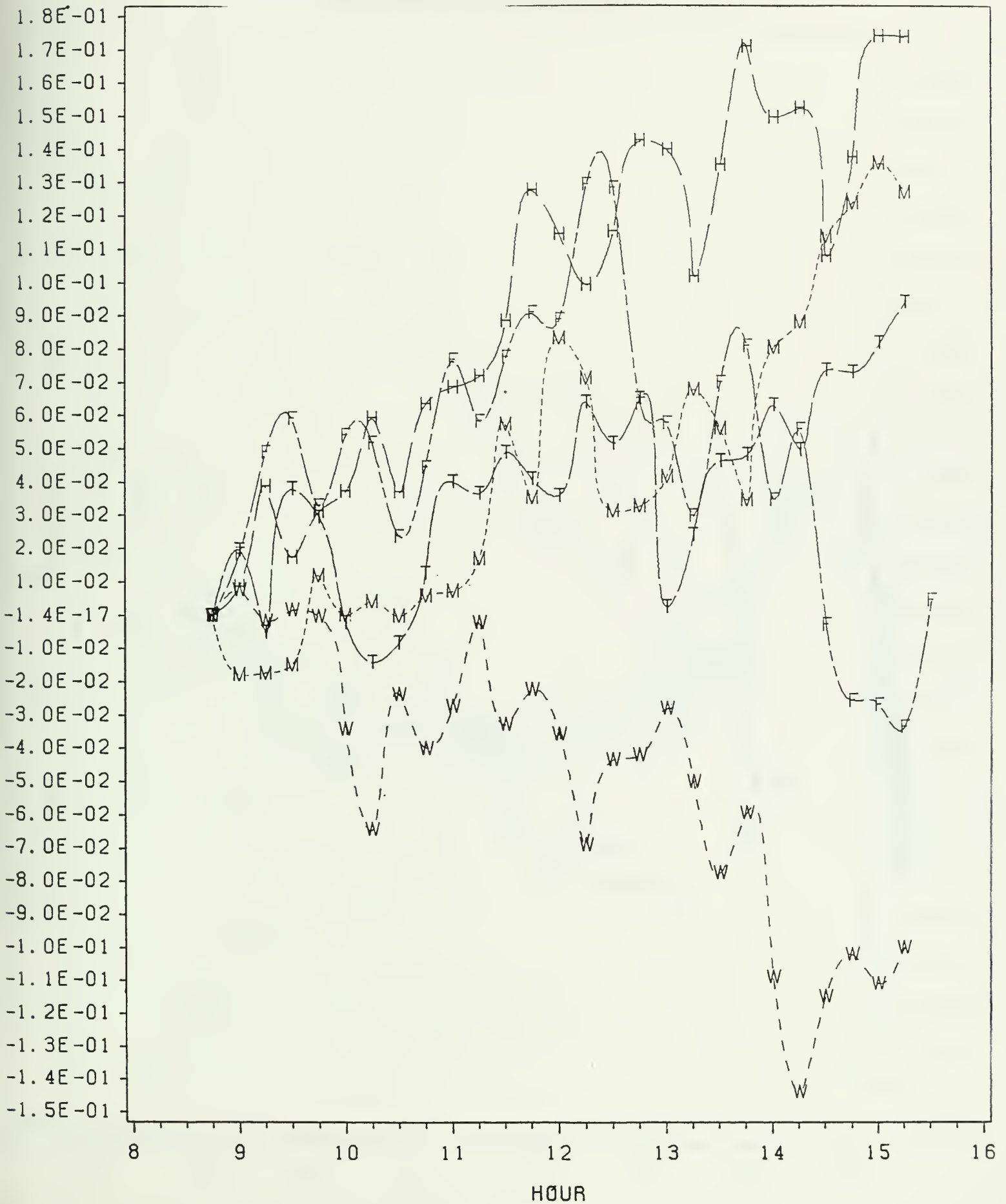


Figure 3

Cumulated 15-Minute Intraday Returns (Spot)

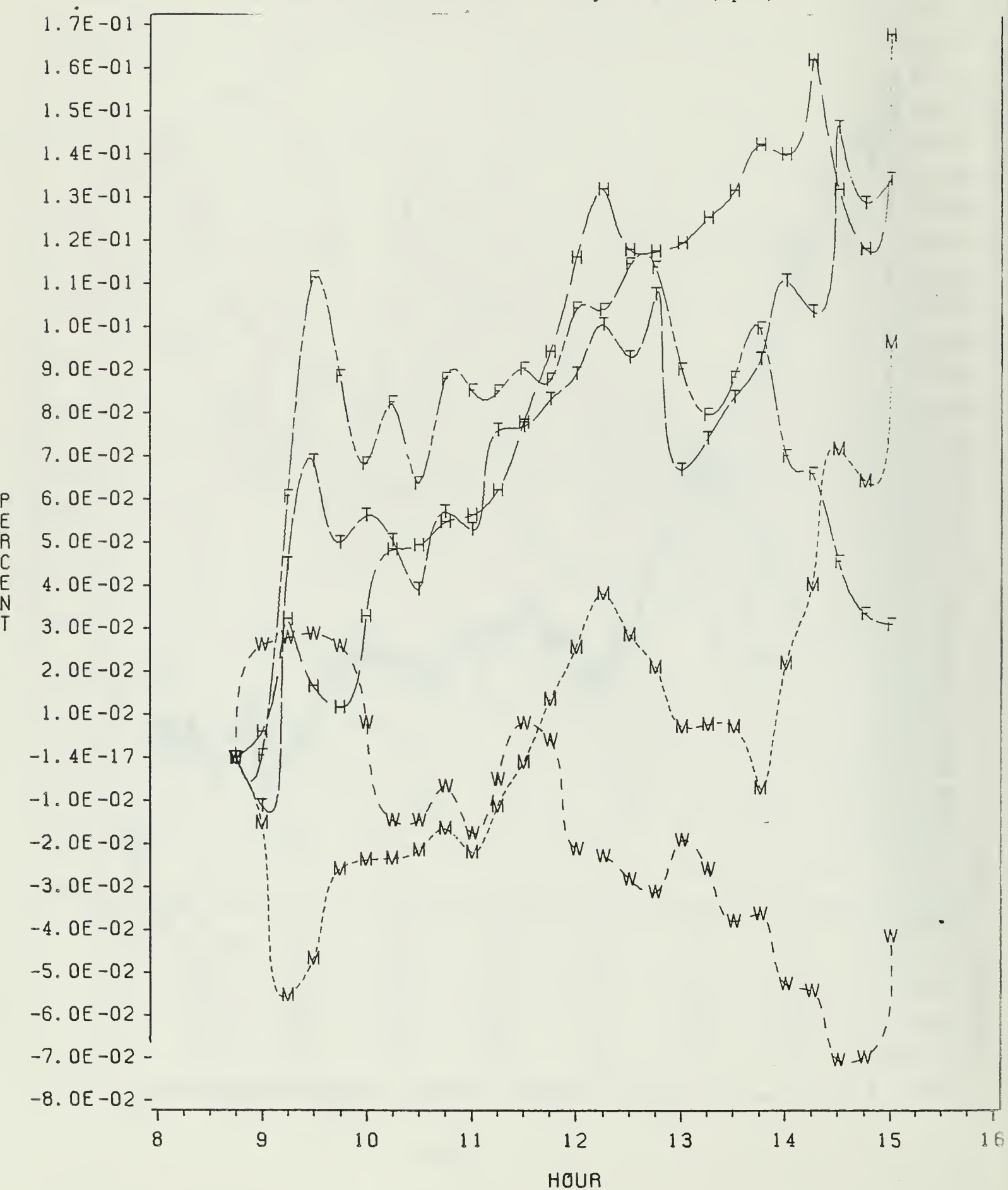


Figure 4

Intraday Price Volatility Behavior (Futures)

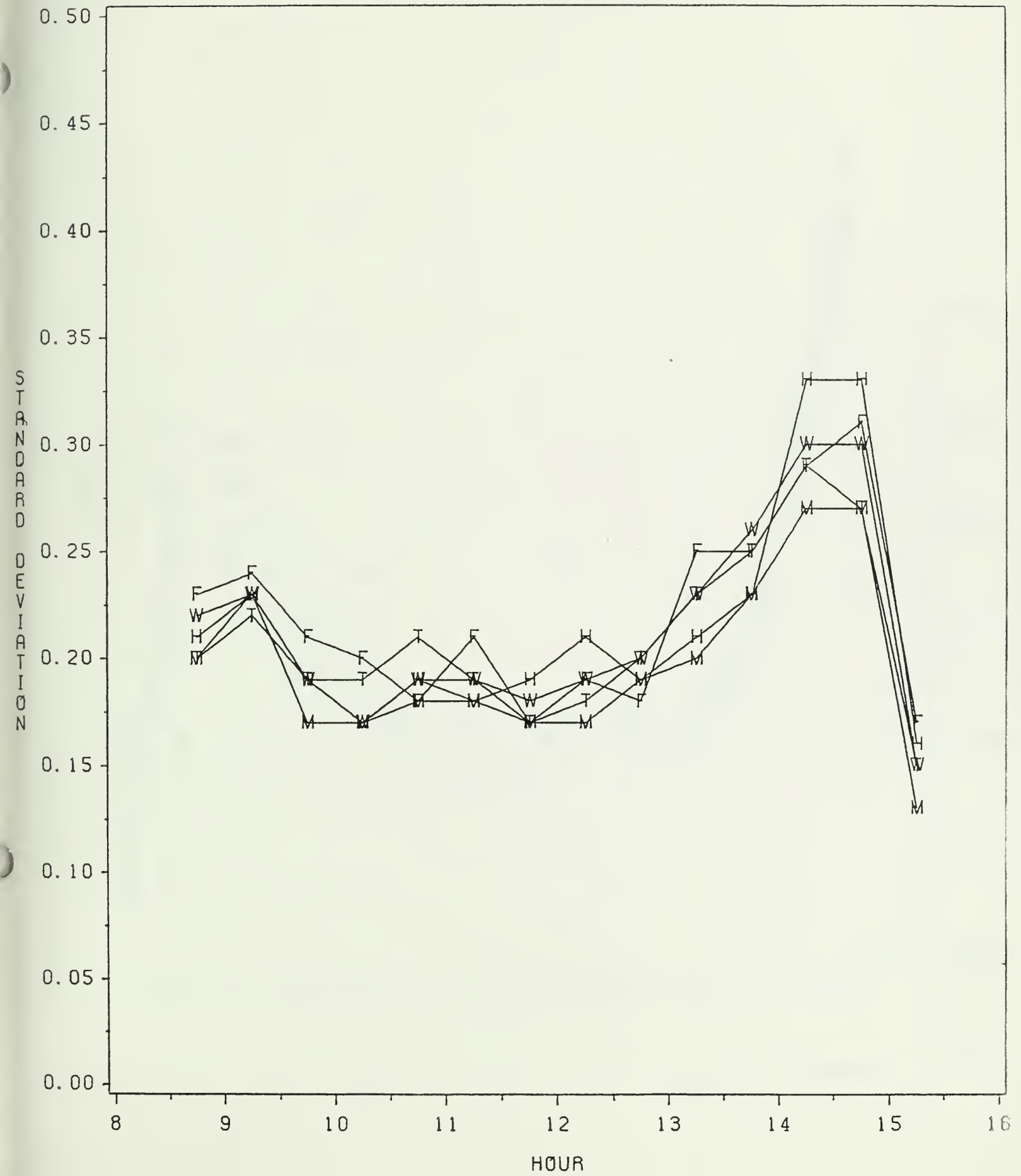
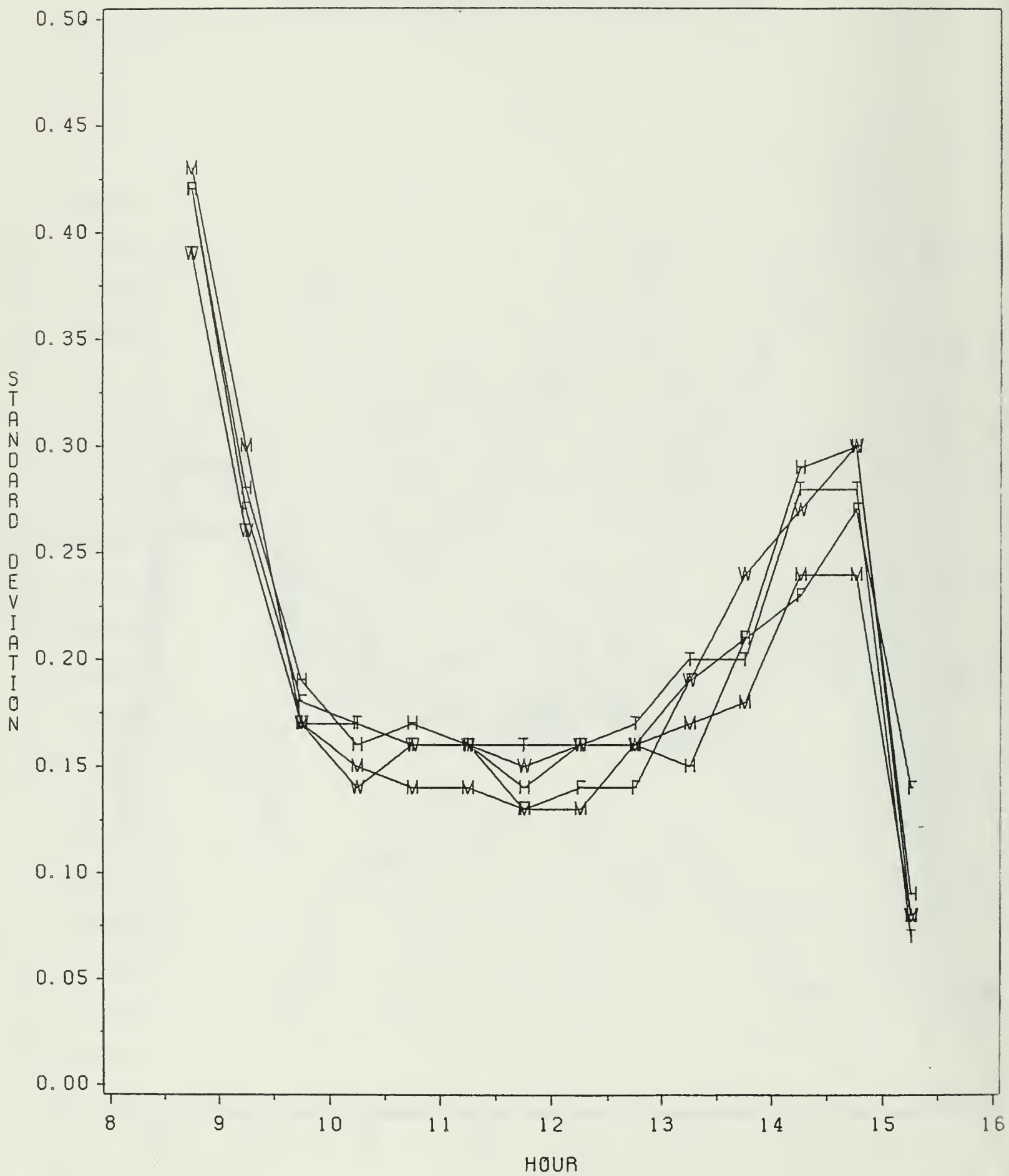


Figure 5

Intraday Price Volatility Behavior (Spot)



Appendix

The Major Market Index Companies*

1. American Express
2. AT&T (new)
3. Chevron
4. Dupont
5. Eastman Kodak
6. Exxon
7. General Electric
8. General Motors
9. IBM
10. Inter Paper
11. Merck
12. Minn M&M
13. Procter & Gamble
14. Sears, Roebuck
15. U.S. Steel
16. Coca Cola
17. Dow Chemical
18. Johnson and Johnson
19. Mobil
20. Phillip Morris

*The first 15 companies are also included in the DJIA, the price-weighted average of 30 NYSE blue-chip stocks.

UNIVERSITY OF ILLINOIS-URBANA



3 0112 060296065